districts' as affected by their animal inhabitants; mine to the aggregations of animals according to their habitats.

The differences are counterbalanced by the resemblances in other respects. Let me close then by endorsing the favorable criticism of Dr. Ortmann's work by Dr. Baur and commending it as well worthy of attention.

THEO. GILL.

RÖNTGEN RAY EXPERIMENTS.

EXPERIMENTS with Röntgen Rays have been carried on very persistently at Case School of Applied Science for several weeks, and some very interesting results have been obtained. The main object has been to secure good photographs of the human skeleton in a living subject, and to increase the practical efficiency of the apparatus. The accompanying photographs of the bones of the hand and forearm, and of an aluminium medal, will indicate the degree of success obtained.

The arm was photographed with an exposure of twenty minutes, while the medal ($\frac{1}{16}$ inch thick) required but five minutes. The Crookes tube used is of the well-known spherical form, having four electrodes, designed to show that the discharge in a high vacuum is independent of the anode, and is one of a set which was exhibited at the World's Fair. It was excited by an induction coil giving about a six-inch spark in air, when using a current of three amperes and twenty volts, obtained from eleven cells of storage battery. The arm was held by bandages to the plateholder, which was supported in an inclined position upon a special stand. The usual plateholder slide of hard pasteboard was between the hand and plate. The tube was placed at a distance of twelve inches above the wrist. Rapid plates were used and developed in the usual way with eikonogen and hydrochinon developer. Slow lantern slide plates give nearly as good results, indicating that the sensitiveness of the plate to ordinary light is no criterion in this work. A great deal of detail appears plainly during development which disappears in the 'fixing' process. Various kinds of developers and fixing agents have been tried to overcome this, without success.

A photograph showing the bones of the fingers has been made with ten seconds' exposure, the tube being two inches above the plate. The bones of the entire arm, including the shoulder joint and of the foot, have been satisfactorily photographed. Attempts have been made to photograph the chest and head with exposures of one hour in each case, the tube being eighteen inches from the plate. The resulting negatives show a surprising amount of detail, which is too faint for satisfactory reproduction. The chest picture shows eight ribs on each side of the spinal column, a dark streak in the latter corresponding to the spinal cord. Under the region of the heart the ribs do not show, indicating that the heart is more opaque than the lung tissue. The collar bone is prominent, while the details of the shoulder joint can be seen. The picture of the head shows the following details: The spinal column in the neck, the jaw bones, with teeth and spaces where several are missing, the nasal cavities, the thickening of the bone showing clearly the outline of the ear, the thin places at the temples, the floor of the brain cavity and the ragged edge where bone and cartilage join in the nose. These pictures, though of little surgical value, are very interesting experimentally. Some of the negatives made clearly show the ligaments connecting the bones at the joints, while none have so far shown any blood vessels or nerves.

Bullets have been located in the hands of four men, and numerous cases of hands injured by machinery and of deformities have been examined, the exposures varying from two to twenty minutes. Some very interesting and valuable pictures of diseased arm bones and of fractures of the arm have been taken. In one case four inches of the arm bone had been removed five years ago, and the extent of the disease is clearly shown. Views of the fractures where the ends of the bones are not in apposition are of value to the surgeons. These photographs are taken through bandages, splints and silicate of sodium casts without hindrance.

A most interesting study has been the position of the various small bones of the wrist in different positions of the hand.

Many interesting points are noted in the work, which are suggestive in a theoretical way, details of which are not ready for publication.

As already announced by Prof. Rowland, it appears that the anode is as important in the matter as the cathode. We have a number of tubes which give results, but none better than the one mentioned, while a tube just received, of American manufacture, promises to equal the imported ones.

The success so far obtained with the arm and chest encourages us to think that still thicker portions of the human body may be studied advantageously, and experiments will be immediately undertaken in this direction.

DAYTON C. MILLER.
CASE SCHOOL OF APPLIED SCIENCE,
March 25, 1896.

[The photographs referred to by Prof. Miller, like all others of a similar character, are difficult of adequate reproduction by photogravure. The bones of the wrist and the large bones of the forearm are splendidly shown and the aluminum medal shows detail nearly as well as an ordinary direct photograph. T. C. M.]

THE INVERTED IMAGE ON THE RETINA.

I CANNOT justly take to myself the severe remarks which Prof. Brooks makes, in the last number of SCIENCE, concerning those who have understood him to mean that there is something peculiarly inconceivable in the *inversion* of the image on the retina; I did not myself take this view, because I happened to know, before writing my letter, that he disavowed this interpretation of his words. I even fail to understand by what rule of logic he drew the conclusion that he was the distinguished scientist to whom I alluded when I used these words: "Prof. Brooks can hardly hope that there should be any consensus among scientific men in regard to * * * * * *consciousness*, if *there are still distinguished scientists* who think that there is anything which needs explanation in the fact that the image on the retina is inverted." (I add the italics now.) This view of the matter is not uncommon, as the following instances, in addition to the discussion which has been going on for more than six months in SCIENCE, and which Prof. Brooks has found so wearisome, will indicate. A physician who had been travelling among the Esquimaux recently reported before a medical society in Philadelphia that those people are in the habit of holding a picture upside down when it is given them to look at; he accounted for this curious fact by supposing that they were in such a low state of development that they had not yet learned to reinvert the image on the retina, and this hypothesis was seriously discussed by this body of physicians, without having its absurdity pointed out by a single member. As another instance, I mention that a prominent Baltimore physician, in writing on the sensations of infants, lately said that they see everything upside down at first, and only learn afterwards to correct this impression.

Since Prof. Brooks has included me among those who have failed to take his meaning as he intended it, he cannot complain if I come to their defence in a single word. He had said: "We all believe many things that are inconceivable, such as the truth that the image in the retina is upside down;" and again, "I illustrated, by the inversion of the retinal image, the fact that evidence may furnish conclusive proof of truths that are inconceivable." Now, while it is true that "if, for purposes of illustration, I declare my conviction that the moon is not made of green cheese," no one has a right to infer that I think the moon is made of cheese of any kind, this supposititious assertion offers no analogy to the case in hand. If a person said that he could not believe that *the cheese of which the moon is made is green*, and also that he was not able to believe in the *greenness of the cheese of which the moon is made*, he would be using expressions precisely analogous to those made use of by Prof. Brooks in the case of the retinal image. Would anyone be expected to use language like this, unless it was the greenness only that troubled him?

C. L. F.

NECESSARY AND SUFFICIENT TESTS OF TRUTH.

EDITOR OF SCIENCE: When Prof. Brooks says that it is a 'great law of logic that the test of truth is evidence and not conceivability,' he uses the phrase 'test of truth' in a loose way which (while it is not uncommon), in the interests of logic, I must protest against.

To the mathematician it has long been a